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(54) Water -dispersible tablets containing lamotrigine

(57) A water-dispersible tablet is provided having 5 to 500mg lamotrigine comprising 2% w/w to 90% w/w lamotrigine, 0.25 to 40% w/w of a pharmaceutically acceptable swellable clay which is present within the granules of the tablet, and an effective amount of an additional pharmaceutically acceptable swellable clay which is present within the granules of the tablet. The tablet is capable of dispersing in water within a period of 3 minutes to provide a dispersion which is capable of passing through a sieve screen with a mesh aperture of 710µm in accordance with the test for dispersible tablets defined in the British Pharmacopoea 1988, volume II, page 895.

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### WATER-DISPERSIBLE TABLETS

The present invention relates to a water-dispersible tablet formulation containing lamotrigine (EP Nos. 021,121 and EP 247,829).

Therapeutically active compounds or drugs are frequently administered to patients in tablet form where the drug is intended for oral administration since tablets are an especially convenient pharmaceutical form for manufacture, storage and generally usage. However, problems, may arise with the administration of such tablets to patients who have difficulty in swallowing the tablets (for example, children or more seriously ill patients) especially if the tablets are large in size arising from the amount of drug required in each tablet. A solution to such problems is to formulate the tablets in a form whereby they can be dispersed in water to form a dispersion containing the drug which can then be drunk by the patient.

Known water-dispersible tablets include effervescent formulations which rely on the formation of a gas to quickly break up the tablet, but these involve expensive methods of manufacture and strict regulations for such manufacture. Other known water-dispersible tablets use disintegrating agents such as microcrystalline cellulose used in Feldene ® dispersible tablets.

According to a first aspect of the invention there is provided a water-dispersible tablet having 5 to 500mg lamotrigine comprising 2% w/w/ to 90% w/w lamotrigine, 0.25 to 40% w/w of a pharmaceutically acceptable swellable clay which is present within the granules of the tablet to provide a tablet which is capable of dispersing in water within a period of 3 minutes to provide a dispersion which is capable of passing through a sieve screen with a mesh aperture of 710µm in accordance with the test for dispersible tablets defined in the British Pharmacopoea 1988, volume II, page 895.

Swellable clays such as Veegum<sup>R</sup> and other magnesium aluminium silicates have previously been studied and proposed for use as disintegrating agents, binders and lubricants in the manufacture of tablets, but such studies and proposals were exclusively with respect to tablets intended for swallowing and not for water-dispersible tablets (Rubenstein, *Pharmaceutics - The Science of Dosage Form Design* (1990) for disintegrants see p 312 and 314). Moreover, there has never been any suggestion that a clay would be suitable to meet the more stringent requirements for dispersible tablets. Tablets for

swallowing need only have a disintegration time in water of less 15 minutes and be able to form particles on disintegration in water that can pass through a 2.00mm mesh aperture (British Pharmacopia test for swallowable tablets). Such long disintegration times and large particle sizes are entirely unsuitable for a dispersible tablet.

Even when swellable clays have been proposed as disintegrating agents for swallowable tablets, they are not regarded as very suitable for such use because their off-white appearance can often discolour the tablet and because they are not as effective as other disintegrating agents (Banker and Anderson - Theory and Practice of Industrial Pharmacy p 328 (1986) and Bhargava *et al* - Drug Development and Industrial Pharmacy, 17(15), 2093-2102(1991)). In fact, bentonite is identified in Marshall and Rudnic, Modern Pharmaceutics (1990) p 374, as the least swellable of the ten disintegrants listed. There is no mention in the above text-book references of how the swellable clay should be incorporated - i.e. by intra-granular addition or by extra-granular addition. In the former case, the clay would be included in the mixture from which the granulate is formed; in the latter case the clay would be added to the pre-formed granulate.

In J. Pharm. Sci, 55, 1244 (1966), Wai *et al.* reviewed the following papers relating to swellable clays such as Veegum and bentonite as disintegrating agents: Wai *et al.*, J.Pharm.Sci, 55, 1215(1966); Granberg *et al.*, J.Am.Pharm.Assoc.Sci, 38, 648(1949); Gross *et al.*, J.Am.Pharm.Assoc.Sci, 41, 157(1952); Firouzabadian *et al.*, J.Am.Pharm.Assoc.Sci, 43, 248(1954); Ward *et al.*, Drug Cosmetic Ind, 91, 35(1962); Nair *et al.*, J.Am.Pharm.Assoc.Sci, 46, 131(1957); and Patel *et al.*, Indian J.Pharm., 19, Jan.1957. Wai *et al.*, then compared three grades of Veegum evaluating both extra-granular and intra-granular addition and concluded that "the clays were not good disintegrating agents when wet granulated" (i.e. intra-granular addition), and then went on to recommend extra-granular addition. Furthermore R.T.Vanderbilt and Co. (Manufacturers of Veegum) in their publication "Veegum - The Versatile Ingredient for Pharmaceutical Formulations" at p 19 describe a tablet formulation in which Veegum is added after granulation (tablet No.2). There is no reference in the publication to a formulation of a tablet in which Veegum is added during granulation.

In contrast to the above recommendations, we have found that a swellable clay such as Veegum must be added during granulation to meet the British Pharmacopoeia (B.P.) standard for dispersible tablets (presently set at a dispersion time of 3 minutes or less). If the swellable clay is added only after granulation the dispersion time is too high to meet

the above standard.

By using Veegum and other swellable clays in the manner described above, we have been able to prepare water-dispersible tablets containing a variety of therapeutically active compounds. The resulting tablets can readily be dispersed in water to form a dispersion which can be drunk by a patient.

The present invention further provides a process for the preparation of a water-dispersible tablet said process comprising bringing lamotrigine into association with said swellable clay and additional disintegrating agent to form granules, and then compressing the granules to form a tablet which is capable of dispersing in water within a period of 3 minutes to provide a dispersion which is capable of passing through a sieve screen with a mesh aperture of 710 $\mu$ m in accordance with the test for dispersible tablets defined in the British Pharmacopoeia, 1988, volume II, page 895.

Preferably said process comprises the steps of:

- a) admixing in dry, finely-divided form Lamotrigine, the swellable clay and the additional disintegrating agent, optionally with the addition of one or more other pharmaceutical carriers or excipients;
- b) addition of a quantity of a pharmaceutically acceptable liquid sufficient to moisten the dry mixture;
- c) granulation of the resulting moist mixture with a granulating fluid to form granules;
- d) drying the granules and optionally blending the granules with other optional carriers or excipients such as lubricants, glidants, and flavouring agents; and
- e) compression of the granules to form a tablet which is capable of dispersing in water within a period of 3 minutes to provide a dispersion which will pass through a sieve screen with a mesh aperture of 710 $\mu$ m in accordance with the above-defined British Pharmacopoeia test for dispersible tablets.

A tablet according to the invention, as well as being quickly dispersible in water, has the added advantage that it meets the British Pharmacopoeia (B.P.) test for dispersible tablets

in respect of dispersion times and dispersion quality (i.e. passage through a 710 $\mu$ m sieve).

Preferably the dispersion time of a tablet according to the invention is less than 2 minutes, more preferably less than 1.50 minutes and most preferably less than 1 minute.

A further advantage of the tablets according to invention is that because a relatively fine dispersion is formed the tablet will have a lower dissolution time and thus the drug may be absorbed into the blood stream much faster. Furthermore the fast dispersion times and relatively fine dispersions obtained with tablets according to the invention are also advantageous for swallowable tablets. Thus tablets according to the invention can be presented both for dispersion in water and also for directly swallowing. Those tablets according to the invention that are intended for swelling are preferably film-coated to aid swallowing. Such film-coating however increases the dispersion time up to 5 minutes determined in accordance with the above-mentioned B.P. test.

The references herein to tablets according to the invention include both film-coated and non-film-coated tablets.

After the dispersion has passed through the 710 $\mu$ m mesh screen, there should be substantially no residue, except fragments of undissolved tablet coating or shell, remaining on the screen or adhering to the lower surface of the disc, if a disc optionally has been used; and if any residue remains, it should consist of a soft mass having no palpably firm, unmoistened core.

The particle size distribution of the dispersion are set out in the following table with the increasingly preferred values being quoted from left to right.

Particle Size ( $\mu$ m)*	BP Standard	Preferably	More Preferably	Most Preferably
<710	<100%	100%	100%	100%
<300	-	>50%	>70%	>80%
<200	-	-	>50%	>70%

<150

>50%

\* (equivalent spherical volume diameter)

Lamotrigine, i.e.(3,5-diamino-6-(2,3-dichlorophenyl)-1,2,4-triazine, and its pharmaceutically acceptable salts which have acceptable dispersibility in water are included in the invention. Thus, for example, a suitable salt of lamotrigine is the isethionate salt (i.e. 2-hydroxymethanesulphonate). It will be appreciated that reference to any active compound also includes any pharmaceutically acceptable salts thereof.

The term "swellable clay" as used herein includes layered clays (such as smectites), porous fibrous clay minerals, and synthetic clay materials related in structure to layered clays and porous fibrous clays.

The term "layered clays" as used herein includes substantially homogeneous layered clays and mixtures thereof, and interstratified or mixed layered clays. Substantially homogeneous layered clays includes the smectite group for example dioctahedral and trioctahedral types. Examples of dioctahedral smectites are the montmorillonite group (montmorillonoids); magnesium and other (e.g. calcium) aluminium silicates such as Veegum in its various grades e.g. Veegum, Veegum HV, Veegum F, and Veegum WG); almasilate; fullers earth (e.g. Surrey finest); American fullers earth; bentonite; beidellite; cheto montmorillonite, Wyoming montmorillonite, Utah montmorillonite; Tatalia and Chambers montmorillonites; and iron rich smectites such as nontrite (e.g. Garfield nontronite) and ferrian smectites.

Examples of trioctahedral smectites (also known as saponites) are Swinefordite, hectorite, stevensite. Examples of smectites containing more unusual elements are Volkhonsite, Medmontite, Sauconite, nickel smectites and vanadium smectites. As well as the montmorillonite group, related smectites such as vermiculites may also have application.

The term "interstratified or mixed layer clays", as used herein includes clays involving different layers arranged in a regular or irregular structure. The most common examples of such clays have generally two components in substantially equal proportions and have been given mineral names such as rectorite (mica-smectite), hydrobiotite (biotite-vermiculite), corrensiten (chlorite-smectite) allettite (talca-saponite). More irregular arrangements include illite-smectite, chlorite-smectite, and kaolinite-smectite. Further examples of

interstratified clays are tosudite, tarasovite, alleverdite, Japanese bentonite ("acid clays"), AWAZU acid clay, and kaolinite-smectite. Other mixed layer clays may include one or more of the following minerals: clinchlore, chamosite, nimate, thuringite, sudoite, and cookeite. Mixed layer smectities are also known e.g. interdispersed montmorillonite and beidellite layers. The layers of mixed layer clays may be homogeneous or non-homogeneous.

The term "porous fibrous clays" includes palygorskite and sepiolite such as, for example attapulgite and American fuller's earth.

The term "synthetic clay materials" as used herein includes materials related in structure to layered clays and porous fibrous clays such as synthetic hectorite (lithium magnesium sodium silicate) for example laponite<sup>R</sup>.

It will be appreciated that within the scope of the invention the following classes of clays have application alone or in combination and in mixed layer clays: kaolinites, serpentines, pyrophyllites, talc, micas and brittle micas, chlorites, smectites and vermiculites, palygorskites and sepiolites. Other phyllosilicates (clay minerals) which may be employed in the tablets according to the invention are allophane and imogolite.

The following references describe the characterisation of clays of the above types: Chemistry of Clay and Clay Minerals. Edited by A.C.D. Newman. Mineralogical Society Monograph No. 6, 1987, Chapter 1; S.W. Bailey; Summary of recommendations of AIPEA Nomenclature Committee, Clay Minerals 15, 85-93; and A Handbook of Determinative Methods in Mineralogy, 1987, Chapter 1 by P.L. Hall.

Suitably the swellable clay is a pharmaceutically acceptable crystalline mineral clay having a lattice structure which expands upon hydration, preferably a pharmaceutically acceptable smectite or attapulgite clay, especially a montmorillonoid, more preferably yet a montmorillonoid chosen from the group consisting of montmorillonite, sauconite, vermiculite, bentonite and hectorite, still more preferably an aluminium magnesium silicate and most preferably Veegum<sup>R</sup>.

The term "smectite" as used herein in relation to tablets of the present invention includes the smectites as exemplified herein and with reference to O'Brian P. and Williamson C.J., in "Clays and Clay Minerals vol. 38 No. 3 pp322-326, 1990" and the other clay

nomenclature references set out hereinbefore.

The term "magnesium aluminium silicate" as used herein in relation to tablets of the present invention should be understood to include the Aluminium Magnesium Silicate defined in the British Pharmacopoeia, volume 1, pages 27-28, 1988 and the Magnesium Aluminium Silicate defined in the United States Pharmacopoeia, National Formulary XVI, pages 1943-1944, 1990. Advantageously, said silicate is in the form of a microfine powder having a No. 325 US Standard mesh particle size, a viscosity of 250 cps ( $\pm 25\%$ ) for a 5.5% (w/v) aqueous dispersion and an acid demand (the volume in ml. of 0.1N hydrochloric acid required to reduce the pH of one gram to 4) of 6-8: such a material is available as VEEGUM F (R.T. Vanderbilt Co., New York, N.Y., U.S.A.; K & K-Greeff Chemicals Ltd., Croydon, Surrey CR9 3QL, England).

For a dispersible tablet containing lamotrigine, the intra-granular amount of swellable clay such as a crystalline mineral clay for example, magnesium aluminium silicate is suitably present in the following general ranges 0.25 to 60% w/w, preferably 0.25 to 50% w/w, more preferably 0.5 to 50% w/w, more preferably still 1 to 50% w/w, more preferably still 1 to 40% w/w, more preferably still 2 to 20% w/w, more preferably still 2.5 to 20% w/w, still more preferably 1 to 10% w/w, still more preferably 3 to 10% w/w, and most preferably 5 to 10%, most desirably about 5% w/w.

The tablets according to the invention will generally contain a pre-determined amount of lamotrigine.

The tablets according to the invention conveniently contain 2.5 to 500 mg. desirably 5 to 250 mg. of lamotrigine (or a pharmaceutically acceptable salt thereof) calculated as lamotrigine base. Preferred said unit doses include 5 mg., 12.5 mg., 25 mg., 50 mg., 100 mg., 150 mg., 200 mg. and 250 mg., calculated as the base. For tablets having a total weight of about 55 to 65mg and containing about 5mg lamotrigine, the swellable clay, e.g. Veegum F, is preferably present in an amount of 2 to 4mg, especially about 3mg. Similarly for a tablet having a weight of about 220 to 350mg and containing about 80 to 120mg, preferably 100mg of lamotrigine, the swellable clay, e.g. Veegum F, is preferably present in amount of 5 to 20mg, especially about 12mg.

In general the tablets according to the invention contain lamotrigine in the following percentage proportions - Lamotrigine - 3 to 90% w/w, preferably 5 to 40% w/w.

The said lamotrigine dispersible tablets may be employed in human medicine in the treatment of disorders of the central nervous system and in particular in the treatment of epileptic seizures. They may be administered one or more times per day, for example up to five times per day, at the discretion of the attendant physician and dependent upon the age and condition of the patient, the particular disorder being treated, the unit dose adopted and the total dose required. A suitable daily dose for the treatment of epileptic seizures will generally lie in the range of 5 to 500 mg., more often in the range of 25 to 400 mg., calculated as the base.

The physical size of the said tablets is desirably such as to permit their dispersion, prior to oral ingestion, in an acceptably small volume of water. Thus, for example, a tablet containing 5 mg. (calculated as the base) of lamotrigine or a salt thereof, a dose especially suitable for paediatric use, is advantageously small enough to disperse in the volume of water held in a standard 5 ml. medicine spoon.

Tablets of the invention containing lamotrigine (or a salt thereof) advantageously include a magnesium aluminium silicate such as Veegum F as the swellable clay together with further optional pharmaceutical carriers or excipients referred to above such as binders, lubricants, fillers etc.

In such tablets the ingredients are advantageously present in the following proportions: lamotrigine: 2% w/w to 90% w/w preferably 5% w/w to 40% w/w; swellable clay: 0.25% w/w to 40% w/w preferably 0.25% w/w to 10% w/w.

When the active compound is present in an amount of at least 60% w/w in tablets according to the invention, we have surprisingly found that the dispersion time remains substantially constant over a range of tablet hardnesses. This is a considerable quality control advantage since in industrial manufacture it is essential to maintain a constant tablet hardness. Tablets according to the invention can thus be produced with sufficient hardness and friability so that they can easily be film-coated. A tablet according to the invention should desirably have a friability of about 2% or less, preferably 0.5% or less.

Based on experiments that we have carried out, it has been found that in addition to the amount of swellable clay present within the granules of the tablet, a further amount of swellable clay may be present outside the granules. At very low intra-granular amounts (such as 1% w/w or below), higher extra-granular amounts (such as about 10% w/w or

more) may decrease the dispersion time, but in general extra-granular addition has little or no effect on the dispersion time. The maximum percentage(s) of the clay present within the granules and, optionally outside the granules, may be limited by other practical considerations such as poor flow and compression properties.

Examples of suitable disintegrating agents which can be incorporated into a tablet according to the invention are: microcrystalline cellulose (e.g. Avicel R) 0 to 30% w/w, preferably 5 to 10% w/w, Sodium carboxymethyl cellulose (e.g. Nymcel R) 0 to 5% w/w, preferably 1 to 2% w/w, calcium carboxymethyl cellulose 0 to 20% w/w, preferably 1 to 5% w/w, modified cellulose gum (e.g. Ac-Di-Sol R) 0 to 10% w/w, preferably 1 to 5% w/w, cross-linked povidone 0 to 10% w/w, preferably 2 to 6% w/w, alginic acid and alginates 0 to 10% w/w, 2 to 5% w/w, pregelatinised starch 0 to 10% w/w, preferably 0.5 to 5% w/w, sodium starch glycollate (e.g. Explotab R, Primojel R) 0 to 10% w/w, preferably 0.5 to 5% w/w, modified corn starch (e.g. starch 1500 R) 0 to 20% w/w, preferably 1 to 10% w/w, starch (e.g. potato/maize starch) 0 to 15% w/w, preferably 0.2 to 10% w/w, ion exchange resin such as polacrin potassium (e.g. Amberlite IRP-88) up to 5% w/w, preferably 0.5 to 2.0% w/w.

Work with lamotrigine is supportive of the view that if low hydroxypropyl cellulose (LHPC) is used a suitable dispersion can be obtained without the need for a separate wetting agent/surfactant.

Other excipients suitable for inclusion in the tablets according to the invention include the following:

- a) Binders and Adhesives: we have found that if there is sufficient amount of swellable clay such as Veegum F present within the granules, then a separate binder is not required (i.e. the clay also acts as a binder). Preferably however a separate binder is present in a sufficient amount to provide a tablet having a satisfactory tablet hardness and satisfactory dispersion characteristics. The amount of binder will vary depending on the overall tablet formulation and type of binder used but general functional limits for most tablets of the invention are 0 to 25% w/w. The following binders and amounts are suitable for inclusion in a tablet according to the invention. The concentration of the binder in the granulation fluid (% w/v) is given (% w/w in tablet will vary according to the volume of granulating solution used to form a satisfactory tablet): Examples of binders are: acacia mucilage 0 to 25% w/v, preferably 1 to 5%

w/v, alginic acid 0 to 20.0% w/v, preferably 1 to 5% w/v, polyvinylpyrrolidone (povidone) 0 to 15.0% w/v, preferably 0.5 to 5% w/v, gelatin 0 to 20.0% w/v, preferably 1 to 5.0% w/v, sucrose 0 to 70.0% w/v, preferably 2.0 to 20.0% w/v, starch mucilage 0 to 10.0% w/v, preferably 0.5 to 5.0% w/v, pregelatinised starch 0 to 10.0% w/v, preferably 0.5 to 5.0% w/v, starch paste 0 to 10.0% w/v, preferably 5.0 to 10.0% w/v, sodium alginate 0 to 5.0% w/v, preferably 1.0 to 3.0% w/v, sorbitol 0 to 10.0% w/v, preferably 3.0 to 10.0% w/v, tragacanth 0 to 20% w/v, preferably 5.0 to 10.0% w/v, glucose 0 to 50%, preferably 5 to 25% w/v, hydroxypropylmethyl cellulose (HPMC) 0 to 10% w/v, preferably 1.0 to 5.0% w/v, magnesium aluminium silicate 0 to 40% w/v, preferably 2 to 10% w/v, starch paste 0 to 25% w/v, preferably 5 to 15% w/v, polyvinylpyrrolidone 0 to 15% w/v, preferably 3 to 10% w/v, carboxymethylcellulose sodium 0 to 10% w/v, preferably 1 to 6% w/v, dextrin 0 to 50% w/v, preferably 5 to 25% w/v, ethyl cellulose 0 to 10% w/v, preferably 1 to 6% w/v, polyethylene glycol 0 to 5% w/v, guar gum 0 to 10% w/v, preferably 1 to 5% w/v, zein 0 to 30% w/v, preferably 1 to 10% w/v, hydroxyethyl cellulose 0 to 5% w/v, preferably 2 to 4% w/v, hydroxypropyl cellulose up to 5% w/v, preferably 2 to 4% w/v, methyl cellulose up to 20% w/v, preferably 1 to 10% w/v, polymethacrylates up to 25% w/v, preferably 5 to 10% w/v, carboxymethylcellulose calcium 0 to 20% w/v, preferably 5 to 10% w/v.

- b) Fillers: These serve the purpose of bulking up the tablet to a suitable size and aiding compressibility especially in lower dosage tablets. The amount of filler depends on its type, size of tablet and amount of active compound. When the concentration of active compound is below 60% w/w, more preferably 45% w/w and most preferably below 30% w/w, an inorganic water-insoluble filler is advantageously used. Examples of water-soluble fillers (which can be used in general quantities of 0 to 95% w/w) are: soluble lactose, compressible sugar, confectioners sugar, dextrose, mannitol, sodium chloride, sorbitol, xylitol, sodium chloride F. Examples of water-insoluble fillers (which can be used in general quantities of 0 to 93% w/w) are: calcium carbonate, magnesium carbonate, calcium phosphate (e.g. di and tri basic calcium phosphate), calcium sulphate, kaolin, microcrystalline cellulose, powdered cellulose, pregelatinized starch 5 to 75%, starch, barium sulphate, magnesium trisilicate, aluminium hydroxide.

Inclusion of a filler having a negative heat of solution in water, for example mannitol, sorbitol and xylitol, provides tablets which, in addition to being water-

dispersible, are especially suitable for chewing in the mouth, the dissolving of such an excipient in the saliva producing a cool, pleasant sensation.

- c) Lubricants: Generally lubricants are used in as low an amount as possible. Examples of lubricants with percentage weights which are suitable for a tablet are: stearates (e.g. magnesium or calcium stearate) 0.2 to 5% w/w, preferably 0.25 to 1% w/w, talc 0.19 to 5% w/w, preferably 1 to 2% w/w, polyethylene glycol 0.19 to 5% w/w, preferably 2 to 5% w/w, liquid paraffin 0.18 to 5% w/w, preferably 2 to 5% w/w, sodium lauryl sulphate 0.19 to 5% w/w, preferably 0.5 to 2% w/w, magnesium lauryl sulphate 0.12 to 5% w/w, preferably 1 to 2% w/w, colloidal silicon dioxide 0.1 to 5% w/w, preferably 0.1 to 1.0% w/w, palmitostearate 0.01 to 5% w/w, preferably 1 to 3% w/w, stearic acid 0.01 to 5% w/w, preferably 1 to 3% w/w, zinc stearate 0.01 to 2% w/w, 0.5 to 1.5% w/w, hydrogenated vegetable oil 0.5 to 5% w/w, preferably 1 to 3% w/w. More suitably the lower value is 0.25%.
- d) Wetting agents/surfactants: examples with suitable amounts are: sodium dodecyl sulphate 0 to 10% w/w, preferably 0.5 to 2% w/w, sodium lauryl sulphate 0 to 10% w/w, preferably 0.1 to 3.0% w/w, polyoxyethylene sorbitan fatty acid esters (Tweens) 0 to 3% w/w, preferably 0.05 to 1.0% w/w, polyoxyethylene stearates 0 to 2% w/w, preferably 0.05 to 1.0% w/w, sorbitan fatty acid esters (Spans) 0 to 3% w/w, preferably 0.05 to 1.0% w/w.
- e) Glidants: for example, talc 0 to 5% w/w, preferably 1 to 2% w/w, starch 0 to 15% w/w, preferably 2 to 10% w/w, magnesium stearate up to 5%, preferably 0 - 2.0% w/w, silica derivatives generally 0 to 1% w/w, preferably 0.2 to 0.5% w/w, such as colloidal silica (e.g. Aerosil) 0 to 0-5% w/w, preferably 0.25 to 3% w/w, pyrogenic silica 0 to 2% w/w, preferably 0.25 to 1% w/w, hydrated sodium silicoaluminate 0 to 2% w/w, preferably 0.5 to 1% w/w, colloidal silicon dioxide 0 to 0.5% w/w.
- f) Flavouring agents: are used in for example approximate quantities of 0 to 5% w/w, preferably 0.25 to 2% w/w, orange, cherry and strawberry, raspberry, grape and passion fruit.
- g) Sweetening agents: for example sodium saccharin 0 to 10% w/w, preferably, 0.5 to 5.0% w/w, aspartame 0 to 10% w/w, preferably 0.25 to 5.0% w/w, confectioners sugar 0 to 30% w/w, preferably 5 to 20% w/w, sorbitol 25 to 90% w/w, preferably

0.5 to 10% w/w, sucrose 0 to 85% w/w, preferably 0.5 to 20% w/w, xylitol 0 - 20% w/w, preferably 0.5 to 10% w/w.

Such materials may be incorporated at the appropriate stage(s) of the manufacturing process together with any other agents (e.g. colourants).

Other aspects of the tablet preparation will now be discussed.

Suitably the dry mixing is effected with a mixing time of 5 minutes to 25 minutes preferably about 10 minutes.

The swellable clay can be dry mixed with lamotrigine and other excipients and then granulating solution added, or the clay and other excipients can be dispersed firstly in the granulating solution and then added to lamotrigine and any other excipients prior to granulation.

The liquid employed to moisten the dry mixture, prior to the granulation step, is preferably aqueous, for example water or a mixture of water and a suitable alcohol such as ethanol or isopropanol.

Wet mixing or granulating times which are suitable (depending on the type of mixer used) are 5 to 20 minutes.

Suitable granule drying times and conditions (which will vary according to the type of equipment used and batch size of granules) are about 50 to 80 °C, (using a dryer such as with a tray or fluid bed dryer) to obtain a moisture content generally below about 4%.

Generally suitable compression weights and final table hardness will vary according to the size of tablet, but generally suitable values are as follows:

Approximate Tablet weight (mg)	Approximate Tablet diameter (mm)	Approximate Target tablet hardness (Kp)
60	5.6	1-2
80	6.4	3-4
125	7.4	4-5
250	8.6	5-6
330	9.4	6-8
500	11.0	10-12
600	11.8	10-14
1000	14.0	12-16

The tablets may optionally be film-coated, for example with hydroxypropylmethyl cellulose, polyethylene glycol or titanium dioxide, and/or may be scored and/or may be polished, for example with polyethylene glycol 8000. If the tablets are film-coated, this makes them easier to swallow or chew (i.e. the tablets are suitable for either dispersion in water or for direct swallowing or chewing), but the dispersion time is increased.

The present invention also provides:

- a) Granules, suitable for use in the preparation of a water-dispersible compressed tablet, comprising lamotrigine or a pharmaceutically acceptable salt thereof together with a pharmaceutically acceptable crystalline mineral clay as dispersing agent and an additional pharmaceutically acceptable disintegrating agent;

- b) Use of granules as defined above in the preparation of a water-dispersible compressed tablet which may involve the addition of a further amount of crystalline mineral clay compound after granulation and before compression;
- c) A water-dispersible tablet comprising lamotrigine or a pharmaceutically acceptable salt thereof together with a pharmaceutically acceptable crystalline mineral clay having a lattice structure which expands upon hydration as dispersing agent and an additional pharmaceutically acceptable disintegrating agent. The lamotrigine or a pharmaceutically acceptable salt thereof together with the mineral clay and additional disintegrating agent are comprised within the tablet in granulated form.
- d) A method for the preparation of a lamotrigine water-dispersible tablet which comprises the steps of
- admixture in dry, finely-divided form of lamotrigine or a pharmaceutically acceptable salt thereof, a pharmaceutically acceptable crystalline mineral clay which may be chosen from the group consisting of attapulgite, smectite and montmorillonoid clays or magnesium aluminium silicate, and an additional disintegrating agent;
- optional addition of other pharmaceutical ingredients;
- addition of a quantity of a pharmaceutically acceptable liquid sufficient to moisten the mixture;
- granulation of the resulting moist mass;
- drying of the granules and blending of the granules with optional lubricants, glidant, flavours, etc., and
- formation of the blend into a tablet.
- e) Use in human medicine of a water-dispersible compressed tablet of lamotrigine as defined herebefore.
- f) A method for the treatment in a human being of a disorder of the central nervous

system which comprises administration of a water-dispersible compressed tablet comprising lamotrigine as defined herebefore.

Especially preferred tablets are those wherein the lamotrigine is present as the base.

A suitable formulation of a dispersible tablet containing 25 to 200mg lamotrigine would be:

Lamotrigine	30% w/w to 50% w/w, preferably 35-45%
Calcium carbonate	26% w/w to 46% w/w, preferably 31-41%
LHPC-LH11 or microcrystalline cellulose (e.g. Avicel PH101)	5% w/w to 30% w/w, preferably 5-15%
Magnesium aluminium silicate Veegum F or bentonite	0.25% w/w to 30% w/w, preferably 0.25-10%
Povidone or pre-gelled starch	0.25% w/w to 5.0% w/w, preferably 0.5-2% 1.0% w/w to 8.0% w/w, preferably 2-5%
Sodium starch glycollate	0% w/w to 8% w/w, preferably 0-5%
Magnesium stearate	0.25% w/w to 2% w/w, preferably 0.25-1%

and if optionally film coated:

Opadry 0.1% w/w to 2% w/w, preferably 0.25-1%

Polyethylene glycol 8000 0.1% w/w to 0.5% w/w, preferably 0.1-0.2%

A suitable formulation of a dispersible tablet containing 5mg to 50mg of lamotrigine would be as follows, (values being in % w/w).

Lamotrigine 3-13 preferably 5-11

Lactose or calcium carbonate 50-60 preferably 53-59

Microcrystalline cellulose (e.g. Avicel PH101) or LHPC-LH11 20-35 preferably 24-30

Sodium starch glycollate 0-8 preferably 0-5

Magnesium aluminium silicate 0.25-30 preferably 0.25-10  
Veegum F or bentonite

Povidone K30 0.25-5.0 preferably 0.5-2.0  
or pregelled starch 1.0-8.0 preferably 2-5

Sodium docusate 0-0.5 preferably 0.5-0.15

Sodium saccharine 0-3 preferably 0.5-2

Magnesium stearate 0.25-2 preferably 0.25-1

and if optionally film coated

Opadry 0.1-2.0 preferably 0.25-1

Polyethylene glycol 0.1-0.5 preferably 0.1-0.2  
8000

Examples 1-9 describe the preparation of lamotrigine tablets according to the invention lamotrigine.

Example Number	1	2	3	4	5	6	7	8	9
mg/ tablet	mg/ tablet	mg/ tablet	mg/ tablet	mg/ tablet	mg/ tablet	mg/ tablet	mg/ tablet	mg/ tablet	mg/ tablet
Lamotrigine	100	5.0	5.0	100	100	100	100	100.0	100.0
Calcium carbonate	95	NIL	NIL	NIL	95	NIL	NIL	95.0	90.0
Lactose	NIL	34	35.0	15	NIL	98.1	84		
L HPC-LH11	25	NIL	NIL	NIL	25	NIL	NIL	25.0	25.0
Veegum F	12	3.0	3.0	7.5	12.0	16.0	12	12.0	12.0
Povidone K30	3.0	0.6	0.6	1.5	3.0	3.2	3	3.0	3.0
Explotab	10.0	2.0	1.2	6.0	NIL	12.8	10.0	-	10.0
Sodium									
Saccharin	2.5	0.5	0.5	NIL	NIL	NIL	NIL	-	-
Aspartame	NIL	NIL	NIL	4.0	7.5	NIL	7.5	7.5	7.5
Microcrystalline cellulose									
(Avicel PH101)	NIL	17	17	15	NIL	89.6	23	-	-
Sodium docusate	NIL	0.05	NIL	NIL	NIL	0.26	0.2	-	-
Magnesium stearate	2.5	0.4	0.4	1.5	2.5	3.2	2.5	2.5	2.5
Tablet weight (mg)	250	62.55	62.70	150.5	245	323.16	242.2	245.0	251.24

### Method of Preparation

The tablets described in Examples 1-9 above were prepared according to the following general method:

- (a) A dry mixture was made of all components except Povidone/PVP K30, sodium docusate (if present) and magnesium stearate;
- (b) The Povidone/PVP K30 and sodium docusate (if present) were dissolved in 50% aqueous alcohol to form a granulation solution;
- (c) The granulation solution was added to the dry mixture to form granules;
- (d) The wet granules were dried in a fluid bed dryer;
- (e) The granules were then sifted through a 1000µm diameter mesh sieve; and
- (f) The dried granules were blended with the magnesium stearate and compressed to form tablets.

Flavouring agents where present were added at blending step (f) above.

This general method is illustrated with respect to the following specific examples.

### Uncoated Tablets

- (a) A dry mixture was made of all components except Povidone/PVP K30 and magnesium stearate using a Diosna P100 (high shear mixer - granulator) for 3 minutes.
- (b) The Povidone/PVP K30 was dissolved in 50% aqueous alcohol to form a granulation solution.
- (c) The granulation solution was added to an approximate quantity of 300ml per kg dry weight to the dry mixture to form granules. Wet mixing was carried out for approximately 5 minutes.

- (d) The wet granules were dried in an Aeromatic T3 fluid bed drier at a temperature of  $70^{\circ}\text{C}$  for approximately 30 minutes. The moisture content of the granules was approximately 4%.
- (e) The granules were then sifted through a 1000 $\mu\text{m}$  diameter mesh sieve using a Jackson Crockatt No.7 sifter.
- (f) The dried granules were blended with the magnesium stearate using a collette mixer for approximately 10 minutes and compressed to form tablets using a Manesty D3 Rotary tablet press fitted with caplet shaped punches of approximately 19.3mm length and 9.0mm breadth. Tablets were compressed to a weight of  $1052\text{mg} \pm 2\%$ .

This granule can be used to make other strengths of acyclovir dispersible tablets, e.g. 200mg and 400mg, compressing the dried granules to a weight of respectively 263mg and 526mg, using round punches with diameters of respectively 11.0mm and 8.6mm.

#### Film Coated Tablets

Steps (a) to (f) described were repeated to form an uncoated tablet which was then film-coated by the following procedure.

The film-coating apparatus used was a Manesty Accellacota 10. The coating suspension was sprayed onto the tablet cores to a target weight increase of between 0.5 - 1.0% using suitable parameters of:

- pan rotation speed (8.5 rpm)
- spray (application rate (~20g per min)
- inlet temperature ( $\sim 75^{\circ}\text{C}$ )
- exhaust temperature ( $\sim 53^{\circ}\text{C}$ ).

A polish coat of PEG8000 was then applied to the film-coated tablets, to a further weight gain of 0.1 - 0.2%.

### Further Example

- (a) A dry mixture was made of all components except Povidone/PVP K30 and magnesium stearate using a Z-blade Morton Mixer, mixing for 10 minutes at a slow speed.
- (b) The Povidone/PVP K30 was dissolved in 50% aqueous alcohol to form a granulation solution;
- (c) The granulation solution was added to an approximate quantity of 350ml per kg dry weight to the dry mixture to form granules;
- (d) Wet mixing was carried out for approximately 10 minutes. The wet granules were sieved through a 2000 $\mu$ m mesh sieve;
- (e) The wet granules were dried in an Aeromatic fluid bed drier at a temperature of 70<sup>o</sup> C for approximately 25 minutes;
- (f) The granules were then sifted through a 1000 $\mu$ m diameter mesh sieve;
- (g) The dried granules were blended with the magnesium stearate using a Rotomixer rotary blender for 5 minutes and compressed to form tablets using a Manesty D3 Rotary press fitted with 5.6mm diameter round (normal curvature) punches and dies. Tablets were compressed to a weight of 62.55mg  $\pm$  2%.

Flavouring agents may be added at blending step (g) above.

For a 50mg tablet, the same procedure was used, except that a die of 11.8mm diameter was used and the tablets were compressed to a weight of 625.5mg  $\pm$  2%.

The lamotrigine tablets could be optionally film coated using the same procedure as described above.

The tablets prepared in accordance with the above Examples were then tested as follows.

### Tablet Evaluation Methods

1. Average tablet weight. Twenty tablets were weighed on an analytical balance and the average tablet weight calculated.
2. Tablet breaking strength (kilo pond-kp). 5 tablets were individually tested using a Schleuniger crushing strength tester, and the average breaking strength calculated.
3. Friability (% loss). 10 tablets, accurately weighed, were subjected to 10 minutes friability testing using a Roche Friabilator. The tablets were dedusted, reweighed, and the weight loss due to the friability was calculated as a percentage of the initial weight.
4. Dispersion Disintegration time DT (BP 1988). 6 tablets were tested in accordance to the above-defined BP test (without discs) for dispersible tablets. This utilises water at a temperature of 19-21 °C.
5. Dispersion Quality. In accordance with the BP uniformity of dispersion test for dispersible tablets (BP 1988 Volume II page 895), two tablets were placed in 100ml of water at 19-21 °C and allowed to disperse. A smooth dispersion was produced which passed through a 710µm mesh sieve.

### Granule Evaluation Methods

1. Loss on Drying (LOD). The residual moisture content of the granule (LOD) was determined on a 3-4g sample using a Computrac moisture analyser set to 90 °C operated in accordance with the manufacturer's procedure.
2. Weight Median Diameter (WMD). A 10g sample of granule was sifted for 2 minutes at suitable pulse and sift amplitudes in an Allen Bradley sonic sifter in accordance with manufacturer's instructions. Sieves of 710µm, 500µm, 355µm, 250µm, 150µm, 106µm and 53µm were used. The WMD was calculated from the cumulative percentage undersize size distribution using a computer programme.

Lamotrigine Granule and Tablet Evaluation Results

Example Number	Actual Average Tablet Weight (mg)	Target Tablet Weight (mg)	Average Thickness (mm)	Average Breaking Strength (Kp)	Friability (%)	Disintegration time **	Granule Properties		Tablet shape/ maximum diameter
							Loss on Drying (% LOD)	Weight median diameter WMD (m)	
1)	251.0	250.0	-	4.8	1.32	-	0'24"	74	8.6 round
2a)##	62.06	62.55	2.30	1.5	0.9	-	0'09"	98	5.6 round
2b)	630.0	625.5	5.40	9.6	0.71	-	0'33"	98	11.8 round
3)	61.95	62.70	2.27	1.3	1.3	-	0'06"	102	5.6 round
4)	150.2	150.5	3.32	4.5	1.01	0'23"	0'26"	168	7.4 round
5)	245.7	245.0	-	4.9	1.44	-	0'20"	-	8.6 round
7	237.5	242.2	3.79	5.2	1.42	0'30"	0'36"	182	8.6 round
9a)+	62.4	62.8	-	1.5	1.10	-	0'19"	-	5.6 round
9b)+	248.7	251.24	-	4.5	1.45	-	0'44"	-	8.6 round

+ Tablets containing lamotrigine a) 25mg and b) 100mg made by varying the tablet compression weight.

## Tablets containing a) 5mg and b) 50mg lamotrigine made by varying the tablet compression weight.

The particle size distribution was determined using a Malvern 2600 particle analyser as follows. The instrument was set to analyse particles in liquid with magnetic stirrer fitted. A 300mm focal length lens was used.

1. Disperse tablet in 100ml of de-ionised water.
2. Agitate solution for approximately 2 hours.
3. Filter or centrifuge solution to obtain liquor which should be saturated with all ingredients present in the tablet.
4. Disperse second tablet in 50ml of saturated liquor allowing 3 minutes to fully disperse. Agitate vigorously and remove a sample of the dispersion within 5 minutes adding sufficient quantity to the Malvern PIL cell containing the liquor to obtain an observation value of 0.15-0.30. Analyse sample.

### CLAIMS

- 1) A water-dispersible tablet having 5 to 500mg lamotrigine comprising 2% w/w to 90% w/w lamotrigine, 0.25 to 40% w/w of a pharmaceutically acceptable swellable clay which is present within the granules of the tablet, and an effective amount of an additional pharmaceutically acceptable swellable clay which is present within the granules of the tablet to provide a tablet which is capable of dispersing in water within a period of 3 minutes to provide a dispersion which is capable of passing through a sieve screen with a mesh aperture of 710 $\mu$ m in accordance with the test for dispersible tablets defined in the British Pharmacopoea 1988, volume II, page 895.
- 2) A tablet as claimed in any of the preceding claims wherein the swellable clay is a smectite or attapulgite.
- 3) A tablet as claimed in claim 2 wherein the smectite is selected from the montmorillonite group.
- 4) A tablet as claimed in claim 3 wherein the montmorillonite is magnesium aluminium silicate or bentonite.
- 5) A tablet as claimed in any one of the preceding claims wherein the swellable clay is present within the granules of the tablet in an amount of substantially 1 to 10% w/w..
- 6) A tablet as claimed in any one of the preceding claims wherein the additional pharmaceutically acceptable disintegrating agent is sodium starch glycollate or lowhydroxypropylcellulose.
- 7) A tablet as claimed in any one of the preceding claims which further comprises a binder.
- 8) A tablet as claimed in claim 7 wherein the binder is povidone.
- 9) A tablet as claimed in any one of the preceding claims which further comprises a filler.
- 10) A tablet as claimed in claim 9 wherein the filler is microcrystalline cellulose.

- 11) A tablet as claimed in any one of the preceding claims which is further film coated and wherein the dispersion time can be up to 5 minutes.
- 12) A tablet as claimed in any one of claims 1 to 10 which is capable of dispersing in water within a period of 2 minutes.
- 13) A tablet as claimed in any one of the preceding claims wherein the dispersion contains particles having a particle size distribution of 100% less than 710 $\mu$ m, and more than 50% less than 300 $\mu$ m.
- 14) A tablet as claimed in claim 13 wherein the dispersion contains particles having a particle size distribution of 100% less than 710 $\mu$ m, more than 70% less than 300 $\mu$ m, and more than 50% less than 200 $\mu$ m.
- 15) A tablet as claimed in any one of the preceding claims wherein the tablet contains 25 to 200mg lamotrigine comprises a formulation of 30% w/w to 50% w/w lamotrigine, 26% w/w to 46% w/w calcium carbonate, 5 to 30% w/w lowhydroxypropylcellulose or microcrystalline cellulose, 0.25% w/w to 30% w/w magnesium aluminium silicate or bentonite, 0.25 to 5% w/w povidone or pregelled starch, 0 to 8% w/w sodium starch glycollate, 0.25% w/w to 2% w/w magnesium stearate, and optional film coating composites of 0.1% w/w to 2% w/w opadry and 0.1% w/w to 0.5% w/w polyethylene glycol.
- 16) A tablet as claimed in claim 15 wherein the formulation is 35% w/w to 45% w/w lamotrigine, 31% w/w to 41% w/w calcium carbonate, 5 to 15% w/w lowhydroxypropylcellulose or microcrystalline cellulose, 0.25% w/w to 10% w/w magnesium aluminium silicate or bentonite, 0.5 to 5% w/w povidone or pregelled starch, 0 to 5% w/w sodium starch glycollate, 0.25% w/w to 1% w/w magnesium stearate, and optional film coating composites of 0.25% w/w to 1% w/w opadry and 0.1% w/w to 0.2% w/w polyethylene glycol.
- 17) A tablet as claimed in claim 15 or 16 which contain substantially 25mg or 100mg lamotrigine.
- 18) A tablet as claimed in claim 17 containing substantially 100mg of lamotrigine and having a formulation of 40% w/w lamotrigine, 38% w/w calcium carbonate, 10%

w/w lowhydroxypropylcellulose, 4.8% w/w magnesium aluminium silicate, 1.2% w/w povidone, 4% w/w sodium starch glycollate, 1% w/w sodium saccharin, and 1% w/w magnesium stearate.

- 19) A tablet as claimed in any one of claims 1 to 14 wherein the tablet contains 5mg to 50mg lamotrigine and the formulation comprises 3% w/w to 13% w/w lamotrigine, 50% w/w to 60% w/w lactose or calcium carbonate, 20% w/w to 35% w/w lowhydroxypropylcellulose or microcrystalline cellulose, 0 to 8% w/w sodium starch glycollate, 0.25% w/w to 30% w/w magnesium aluminium silicate or bentonite, 0.25% w/w to 5% w/w povidone or 1% w/w to 8% w/w pregelled starch, 0 to 5% w/w sodium docusate, 0 to 3% sodium saccharine. 0.25% w/w to 2% w/w magnesium stearate, and optional film coating composites of 0.1% w/w to 2% w/w opadry, and 0.1% w/w to 0.5% w/w polyethylene glycol.
- 20) A tablet as claimed in claim 19 wherein the formulation is 5% w/w to 11% w/w lamotrigine, 53% w/w to 59% w/w lactose or calcium carbonate, 24% w/w to 30% w/w lowhydroxypropylcellulose or microcrystalline cellulose, 0 to 5% w/w sodium starch glycollate, 0.25% w/w to 10% w/w magnesium aluminium silicate or bentonite, 0.5% w/w to 2% w/w povidone or 2% w/w to 5% w/w pregelled starch, 0.15% w/w to 0.5% w/w sodium docusate, 0.5% w/w to 2% sodium saccharine. 0.25% w/w to 1% w/w magnesium stearate, and optional film coating composites of 0.25% w/w to 1% w/w opadry, and 0.1% w/w to 0.2% w/w polyethylene glycol.
- 21) A tablet as claimed in claims 19 or 20 which contains substantially 5mg lamotrigine.
- 22) A tablet as claimed in claim 21 containing substantially 5mg lamotrigine and having a formulation of 8% w/w lamotrigine, 54.4% w/w lactose, 4.8% w/w magnesium aluminium silicate, 0.96% povidone, 0.8% w/w sodium saccharine, 0.27% w/w microcrystalline cellulose, 0.08% w/w sodium docusate, and 0.64% w/w magnesium stearate.
- 23) A process for the preparation of a water-dispersible tablet having 5 to 500mg lamotrigine comprising 2% to 90% w/w lamotrigine, 0.25 to 40% of a pharmaceutically acceptable swellable clay and an additional pharmaceutically acceptable disintegrating agent; said process comprising bringing lamotrigine into association with said swellable clay and additional disintegrating agent to form granules, and then compressing the granules to form a tablet which is capable of dispersing in water within a period of 3 minutes to provide a dispersion which is capable of passing through a sieve screen with a mesh aperture of 710µm in

accordance with the test for dispersible tablets defined in the British Pharmacopoeia, 1988, volume II, page 895.

- 24) A process as claimed in claim 23 comprising the steps of:
- a) admixing in dry, finely-divided form lamotrigine, the swellable clay and the additional disintegrating agent, optionally with the addition of one or more other pharmaceutical carriers or excipients;
  - b) addition of a quantity of a pharmaceutically acceptable liquid sufficient to moisten the dry mixture;
  - c) granulation of the resulting moist mixture with a granulating fluid to form granules;
  - d) drying the granules and optionally blending the granules with other optional carriers or excipients such as lubricants, glidants, and flavouring agents; and
  - e) compression of the granules to form a tablet which is capable of dispersing in water within a period of 3 minutes to provide a dispersion which will pass through a sieve screen with a mesh aperture of  $710\mu\text{m}$  in accordance with the above-defined British Pharmacopoeia test for dispersible tablets.
- 25) A process as claimed in claim 23 or 24 wherein the tablet is then further film coated.

**Relevant Technical Fields**

(i) UK Cl (Ed.M) A5B (BLM)

(ii) Int Cl (Ed.5) A61K 9/20

Search Examiner  
J F JENKINS

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28 JULY 1994

**Databases (see below)**

(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) ONLINE DATABASES: WPI, CAS-ONLINE

Documents considered relevant following a search in respect of Claims :-  
1 TO 25

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